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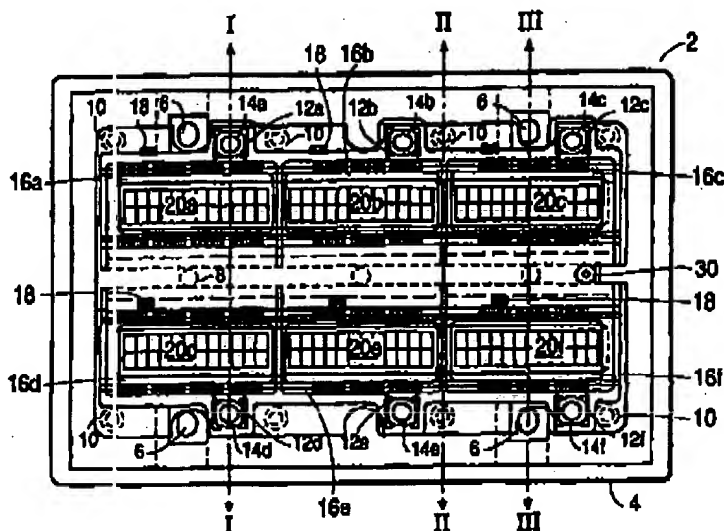
(57) Abstract

Described is a user interface particularly suited for use in a home automation system. This interface combines advantages of a conventional touch screen (such as ease of use and accurate "key" placement) with the advantages of a conventional mechanical keypad (such as reduced cost and tactile feedback). The interface is well suited for use on any wallspace and may be easily reconfigured as necessary to support a host of system functions. The interface utilizes a backlit LCD separated into separate display sections (modules 15 and 17), each having a durable, scratch resistant lens (22). Cantilevered switches (14a to 14f) associated with each display are used to detect a user's selection of a displayed option.

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USER INTERFACE FOR HOME AUTOMATION SYSTEM

FIELD OF THE INVENTION

     This invention relates to an improved interface for
5   interacting with a variety of electronically controlled
systems and appliances. More particularly, the present
invention relates to an improved touchscreen,
particularly suited for use in residential or commercial
automation systems, which provides a consistent, easy to
10   use interface.

BACKGROUND OF THE INVENTION

     In recent years, both the number and variety of
electronic devices and appliances in use have increased
15   dramatically. Lighting systems, personal computers
(PCs), video tape recorders, compact disc (CD) players,
stereo receivers, and televisions are but a few of the
most common devices found in both residential and
commercial settings. Even appliances which rely on non-
20   electric power sources, such as gas burning furnaces, are
usually controlled electronically.

     Reflecting the variety of devices now available,
many different systems and devices are used to provide
more centralized or automated control of the appliances
25   found in the home and the office. These can be as simple
as a remote-control entertainment system comprising a CD
player, stereo and television, or as complex as a
building environmental control system for regulating HVAC
and security functions.

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A central feature of any automation system is the interface by which the user interacts with the automation system. User interfaces permit one to program future operation or to control different devices from a
5   centralized location. Reflecting the variety of appliances or devices that are to be controlled, user interfaces may range widely in complexity. In some settings, a more complicated interface is necessary to provide the broad range of functionality required. For
10   example, a building control center may be sufficiently complicated to require training for the operator. On the other hand, in many environments, particular residential settings, it is essential that interfaces be easy to use and understand so that the entire range of functionality
15   may be utilized.

Unfortunately, the standard approach now commonly used is for each device or system in a given environment to be controlled according to a particular methodology which might differ dramatically from other systems. For
20   example, a home might include a security system, an entertainment system, an environmental control system, and so forth, each with its own unique interface. Thus, a user may be required to set a thermostat in a first manner, program a VTR in a different manner, and program
25   the security system in yet a different manner. By requiring the user to learn several methods of operating each system or set of devices in the environment, it is more difficult for the user to become familiar with the various systems and to take full advantage of all their
30   features.

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Another drawback associated with this standard
approach is that the use of different interfaces may
result in an increase in the amount of space taken up in
the setting. For example, two or more different keypad
5   controllers may be mounted on a wall to separately
control individual systems. As a result, there may be a
decrease in available wall space and a negative impact on
the aesthetic quality of the setting.

Some automation systems attempt to address these
10 limitations through the use of menu driven interfaces
which are connected to a single, dedicated control
processor. With such a system, a user may control
various systems, such as lighting, HVAC, and security,
from a single type of interface which uses a common
15 methodology for interacting with the user. In general,
such interfaces incorporate a display, typically a
cathode ray tube (CRT) or liquid crystal display (LCD),
which provides the user with several options for
controlling one or more systems in the setting.

20 Different types of interfaces are used in menu
driven systems. In some systems, a touch screen is
utilized wherein the user presses a portion of the
display screen to make a selection. The user's
fingertouch is detected and the display indicates which
25 area of the display has been selected. Alternatively,
conventional mechanical switches may be provided in
proximity to the display screen. A graphical image on
the display device directs the user to the appropriate
push-button flanking the display. This approach is

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similar to that adopted in connection with many automated teller machines (ATMs).

Touchscreens are advantageous in that the area in which the user is prompted to make a selection is usually
5   identical to the region which is actually acted upon by the user. For example, virtual buttons may be displayed which are selected on the same display area. On the other hand, touchscreens are relatively expensive and require a fair amount of support by processor and memory
10 elements in order to function properly. Moreover, their use may not prove to be as convenient to the average user as more simple mechanical buttons which provide tactile feedback to the user, usually by a button which clicks when fully depressed.
15   The other above-mentioned approach of providing mechanical switches in proximity to a display screen overcomes these drawbacks, at least in part, in that the mechanical switches may provide tactile feedback. However, since the switches are offset from the display,
20 this approach may require more care in use, particularly in comparison with a touchscreen. In particular, the offset between the switches and the display may make it difficult for a user to determine which button corresponds to a given option. As a result, the user may
25 become disoriented and there may be a delay in the selection of a desired option as the user verifies which switch corresponds to the desired option. Such a delay is clearly unacceptable where the user is attempting to address certain high priority control systems, such as
30 lighting systems or home security. Further, this problem

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may be exacerbated where the display screen contains more
than a few simple commands. Thus, the combination
display/push-button interface is limited by its nature in
the amount of information that may be displayed and the
5   command options that may be offered.

        Accordingly, there is a need for an economical,
menu-driven interface that permits the user to rapidly
and efficiently select a desired function and enter a
desired command. There is a related need for the
10   interface to provide tactile feedback to signal the user
that a command has in fact been entered.

SUMMARY OF THE INVENTION

        It is an object of the invention to meet these needs
15   and to overcome the above-describe shortcomings of
conventional user interfaces.

        It is a further object of the invention to provide a
user interface which comprises: a liquid crystal display
divided into a plurality of regions;
20   a microcontroller operatively coupled to a host
controller, the microcontroller driving the liquid
crystal display according to signals received from the
host controller so as to display text or images on each
of the plurality of regions of the liquid crystal
25   display; a transparent member covering each of the
regions of the liquid crystal display; and a plurality of
switch elements disposed proximal to the regions of the
liquid crystal display, each of the switch elements being
actuated by the transparent member covering it when the
30   transparent member is depressed by a user; wherein the

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microcontroller detects actuation of the switch elements and provides an indication to the host controller in response thereto.

According to one feature of the invention, the user
5   interface further comprises a plurality of light emitting diodes, each disposed proximal to each region of the liquid crystal display, the light emitting diodes being operated by the microcontroller. Optionally, these light emitting diodes are multicolored so as to be indicative
10   of several system states.

According to another feature of the invention, the liquid crystal display is backlit. A light sensor coupled to the microcontroller is used to regulate the intensity of the backlighting of the liquid crystal
15   display depending on the intensity of ambient light detected with the light sensor.

According to another feature of the invention, wherein the transparent member covering the liquid crystal display is made of a scratch resistant, durable
20   material, such as Lexan.

According to still another feature of the invention, the liquid crystal display and the microcontroller are mounted on a printed circuit board which, in turn, is mounted to a wall mounted electrical box. A faceplate is
25   applied to the face of the transparent overlay so as to cover the fasteners which affix assembly to the electrical box.

According to yet another feature of the invention, the host controller provides instructions to the
30   microcontroller whereby a menu of options are displayed

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on the liquid crystal display to the user. The user
indicates selection of a displayed option by depressing
the transparent member over the corresponding region of
the liquid crystal display.

5   Additional objects and features of the invention
will be apparent from the detailed description of the
preferred embodiments set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

10   In the drawings:

Fig. 1A is a front plan view of a printed circuit
board and overlay for a user interface in accordance with
an embodiment of the invention.

Figs. 1B-1D are respective cross-sectional views of
15   the interface of Fig. 1A taken, respectively along lines
I-I, II-II, and III-III.

Fig. 2A is a front plan view of a transparent
overlay in accordance with an embodiment of the
invention.

20   Figs. 2B-2D are respective cross-sectional views of
the transparent of Fig. 2A taken along lines A-A, B-B,
and C-C.

Fig. 3 is a back plan view of the printed circuit
board of Figs. 1A-1D.

25   Fig. 4 is a front plan view of a faceplate in
accordance with an embodiment of the invention.

Fig. 5 is a front plan view of the faceplate of Fig.
4 showing an adhesive layer applied thereto.

Fig. 6 is a cross-sectional view of the faceplate of
30   Fig. 5 taken along line D-D.

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Fig. 7 is a block diagram illustrating the functional aspects of an interface in accordance with the invention.

Figs. 8 to 11 are illustrations of various virtual keypads displayed in a menu driven hierarchy.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Preferred embodiments of the invention are now described in reference to the accompanying drawings. Figs. 1 to 6 illustrate the physical construction of one embodiment of the interface according to the invention. The remaining drawings illustrate the functional aspects of this embodiment of the invention.

As described in detail below, the user interface 2 according to the preferred embodiment principally comprises the following components: a printed circuit board (PCB) 34; a transparent overlay 22; and a faceplate 38. The electronic components of the user interface are mounted to the PCB 34, either directly or by mounting on the reverse side of the PCB 34. The transparent overlay 22 is fastened to the PCB 34 and the combined unit 2 is then mounted in a standard electrical box, such as a three gang box. The faceplate 38 is then applied over the face of the interface to cover the screwheads and to provide a seamless appearance.

Fig. 1A is a front plan view of the PCB 34 with the transparent overlay 22 attached thereto. Figs. 1B to 1D are respective cross-sectional view taken respectively along lines I-I, II-II, and III-III in Fig. 1A.

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Various electronic components are disposed on the front side of the PCB 34. These include two liquid crystal display (LCD) modules (an upper module 15 and a lower module 17) which are each segmented into three

5   display areas so as to provide six display surfaces 20a-20f. In proximity to each of the six display surfaces 20a-20f are respective microswitches 14a-14f and indicator light emitting diodes (LEDs) 18. An optional photosensor 30 is disposed between two of the display

10   portions 14c and 14f.

As explained below, the indicator LEDs 18 serve to provide visual feedback in response to user input and provide an indication of system status. Preferably, bicolored LEDs (red and green) are utilized which can be

15   actuated to produce indications of various states. The indicator LEDs 18 can be turned on, off, or blink. In the on or blinking state, the LEDs 18 can emit a red light, a green light, and also an amber light by lighting the LED both green and red simultaneously. Thus the

20   indicator LEDs 18 are capable of displaying up to seven states (off, solid red, solid green, solid amber, blinking red, blinking green, blinking amber).

In this example, each of the two LCD modules 15 and 17 have displays which are two characters high by forty

25   characters wide. As described below, each display is segmented into through regions, resulting in the loss of six characters per LCD. As a result, each virtual button that is displayed at regions 20a-20f has a display area which is twelve characters wide by two characters high,

30   thus providing a total of twenty-four possible characters

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for display. This segmentation economically increases
the number of apparent discrete displays, even though
only two discrete modules are actually utilized.

In the preferred embodiment, the six display regions
5   20a-20f of the LCDs are individually backlit by a
corresponding set of LEDs to provide enhanced visibility
to the user During times when the ambient background
light is relatively high, it is necessary that the
backlighting be relatively intense so that the display
10   may be seen. When the ambient light is low, it is
preferred that the backlighting be sufficient to
illuminate the LCDs but relatively low enough so as not
to be distracting. According to one variation of the
invention, an optional photosensor 30 is provided on the
15   face of the PCB to detect when the ambient light has
fallen below a predetermined threshold, thereby
indicating to the microcontroller that the backlighting
should be decreased. According to a second variation,
the microcontroller may simply be programmed to maintain
20   the backlighting at a low level until the virtual keypad
is activated by the user, and then return to a low level
after a predetermined time has elapsed.

It is a further feature of the invention that the
LEDs used to backlight the LCDs may be individually
25   controlled at each of the display regions 20a-20f. It is
thus possible to selectively turn on and off various
"virtual buttons" displayed at regions 20a-20f by means
of appropriate programming.

As best seen in Fig. 1A, the transparent overlay 22
30   is attached to the PCB 34 with eight fasteners 10 (screws

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in this example). The fasteners 10 extend through
respective hollow bevels 11 which extend from the surface
of the PCB 34 and through vias in the PCB 34 (see Fig. 1A
and 1C). The bevels 11 and four center supports 8

5   maintain the transparent overlay 22 at a fixed distance
from the surface of the LCD display portions 20a-20f. As
best seen in the cross-sectional views of Figs. 1C and
1D, the LCDs 15 are disposed between the center supports
8 and the bevels 11 so that the front surfaces 20a-20f of

10   the LCDs are covered entirely by the transparent overlay
22.

        The transparent overlay provides six separate touch
areas 16a-16f which cover, respectively, the display
surfaces 20a-20f. Each of these touch areas 16a-16f are

15   connected via a rectangular portion 12a-12f to a post 24
which extends to just above a corresponding microswitch
14a-14f associated with one of the display surfaces 20a-
20f. When the pressure is applied to any of the touch
areas 16a-16f, a post 24 is consequently pushed down onto

20   a corresponding one of the microswitches 14a-14f. Thus,
the touch areas 16a-16f of the transparent overlay 22 act
as cantilevers which activate a corresponding switch 14a-
14f associated with one of the display surfaces 20a-20f.

        The microswitches 14a-14f provide tactile feedback to

25   the user through the posts 24 that are coupled to the
touch areas 16a-16f.

        Once the transparent overlay 22 is fastened to the
PCB 34 (and its associated controller board described
below), the resulting assembly is mounted within a

30   standard three gang box (not shown). The assembly is

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mounted through four oval shaped openings 6 provided on
the transparent overlay 10 (as best seen in Figs. 1A and
1D).   These openings 6 are disposed in recesses in the
front surface of the overlay 10 so as to be disposed over
5   four of the six screw mounts of the three gang box (not
shown).   Unlike conventional components that are normally
mounted in three gang boxes, oval openings 6 are utilized
to permit adjustment of the interface 2 to compensate for
any misalignment of the three gang box.   The recesses for
10   the oval-shaped openings 6 prevent bulging when the
surface of the overlay is covered with the faceplate as
described below.

        While not shown, the assembled interface 2 according
to the preferred embodiment is coupled to a network, such
15   as a home automation system through communication lines
and a power line provided to the three gang box.
Preferably, conventional twenty gauge wire 14 is utilized
to permit standard RS45 communication between the
interface and the host processor of the home automation
20   network.

        Fig. 2A is a front plan view of the transparent
overlay 22.   Figs. 2B to 2D are respective cross-
sectional views of the transparent overlay 22 taken,
respectively, along lines A-A, B-B, and C-C.

25   In this example, the transparent overlay 22
preferably comprises a resilient, scratch-resistant
material, such as polycarbonate GE (generally known as
"LEXAN").   While in the preferred embodiment the
transparent overlay 22 comprises a single piece, it is
30   designed to provide six touch areas 16a-16f, which in

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effect serve as respective clear plastic lenses over the
display regions 20a-20f. Each touch area 16a-16f is
associated with a post 24 by which the above-mentioned
microswitches are activated when any of the touch areas·

5   16a-16f are depressed.

        Fig. 3 is a plan view of the rear surface of the PCB
34. As shown, the integrated circuits provided on the
rear surface of the PCB include respective driver chips
36a-36f which are connected to the LCDs 15 and 17 and the

10   backlight LEDs. Also mounted on the rear surface of the
·PCB 34 is a buzzer 28. The buzzer 28 provide audio
feedback for a variety of situations. For example, it
can be actuate to provide a clicking sound each time one
of the microswitches 14a-14f are actuated to provide

15   audio feedback confirming that a touch has resulting in
selection of an option. It also may be used to signal an
alarm, for example, to indicate that a security system be
disarmed in order to avoid sounding an alarm.

        The PCB 34 is also provided with two sockets 32

20   adapted to receive a processor card. While not shown in
Fig. 3, this card preferably matches the footprint of the
PCB 34 and is disposed parallel to thereto. A relatively
inexpensive. standard eight bit microcontroller is
disposed on the processor card. As explained below, the

25   functions of the microcontroller include: communicating
with the network host controller; controlling the
indicator LEDs 18; receiving ambient light level signals
from the optional photosensor 30; controlling the
backlight LEDs associated with each virtual button;

30   controlling the display drivers which in turn control the

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LCDs; detecting actuation of the microswitches 26; and
actuating the buzzer 28.

Associated with the microcontroller is flash read
only memory (ROM) in which the firmware for basic level
5   functions executed by the microcontroller is written. As
known in the art, the use of flash ROM permits in circuit
reprogramming of the microcontroller without the
necessity of physically removing components from the
circuit board.

10   Fig. 4 is a front plan view of a faceplate 38 which
covers the front surface of the assembled interface 2
once it has been mounted to a wall surface. In the
preferred embodiment of the invention, the faceplate
comprises a silk screen or painted surface having six
15   openings 40a-40f adapted to fit over the touch areas 16a-
16f. In this way, the faceplate 38 covers the screwheads
which affix the interface to the three gang box so as to
provide an aesthetically pleasing, seamless appearance.
In a more functional respect, the faceplate clearly
20   defines the touch areas 16a-16f by covering the unused
portions of the LCDs 15 and 17 as described above. It
thus creates the impression of what is referred to herein
as "virtual buttons" each having text or other images
displayed thereon.

25   The faceplate further includes six transparent or
translucent openings 42a-42f. These openings are
disposed in alignment with the indicator LEDs 18 referred
to above. For aesthetic purposes, it is preferable that
the openings be translucent to such a degree that the
30   LEDs 18 are visible when lit, and not visible when unlit.

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As illustrated in Fig. 5, it is preferred that the faceplate be applied to the surface of the transparent overlay 22 with an adhesive 44. In this way, no fasteners are visible which would interfere with the
5   aesthetic features of the interface.

Fig. 6 is a cross-sectional view of the faceplate 38 taken along a line D-D in Fig. 5. This view illustrates the openings 42b and 42e which are provided in the faceplate 38.

10   From the foregoing description, it should be apparent that the interface according to the preferred embodiment provides several advantages through its unique design. For example, the cantilevered switches associated with the "virtual buttons" formed below the
15   touch regions of the interface provides sensory feedback, both aural feedback with the buzzer and tactile feedback with the microswitches. The LCDs provide a means for displaying an unlimited number of alphanumeric messages in an economical manner. The use of associated indicator
20   LEDs provide yet another simple, but effective means of conveying information to a user, such as system status.

It will be appreciated that the interface according to the invention can be applied in a large number of environments. By way of illustration, application of the
25   interface in a home automation system is now described in reference to Figs. 7 to 11.

Fig. 7 is a block diagram of the functional interaction between the microcontroller 99 and the above identified components of the interface according to the
30   preferred embodiment. As shown, the microcontroller 99

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receives signals from the mechanical switches 98, light
sensor 95, and optional infrared sensor 94. In turn, the
microcontroller 99 provides appropriate signals to
control the LCDs 97, the backlighting panel for the LCDs
5   96, the LED indicators 93, and the buzzer 91.

The microcontroller 99 communicates with a host
computer 91 through a communications port. As noted
above, the preferred embodiment utilizes an RS45
communication system. Of course, other means of
10   communication are possible.

Based on signals received from the host processor,
the microcontroller 99 displays information to the user
through the LED indicators 93 and the LCD panel 97. User
input, detected with the cantilevered switch arrangement
15   noted above, is then provided to the host computer.

Based on this user input, the host computer controls
various systems 92 connected to the network. As noted
above, these controlled systems may include an energy
management system, a security system, an entertainment
20   system, or various other systems.

It will be appreciated that the programming for
control of user interface and the systems attached to the
system principally lies with the host computer. In fact,
it is preferred that the user interface utilize a
25   relatively simple microcontroller having sufficient
memory and firmware to control basic functions, such as
turning on and off the LED indicators and pixels of the
LCDs as instructed by the host computer. While it is
possible to utilize a more expensive microcontroller, it

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is preferred to maintain most processing at the host
level so as to reduce cost.

Maintaining most processing at the host level
further simplifies any necessary programming revisions

5   since changes can be performed centrally, rather than
with each interface. As indicated above, should the need
arise to alter the firmware resident at the interface
level, flash ROM is utilized so that changes may be made
without physically removing ICs from the PCB.

10   Fig. 8 illustrates an example of the a menu driven
virtual keypad display as it appears in the preferred
embodiment of the present invention. Preferably, the
virtual keypad is designed so that six touch actuated
transparent "keys" are superimposed over the LCD display

15   40 to form a display "page". Information is displayed in
each of the six LCD display fields corresponding to a
function that is controlled by the host computer.
Certain controlled functions may be grouped to form a
"menu" according to their level of priority or

20   relatedness. Further, indicator LEDs 101, located
proximal to each key, signal the user that a status
change in a controlled function has occurred.

In the example illustrated in Fig. 8, the displayed
information collectively forms a preconfigured "default

25   menu," wherein information relevant to five high priority
home control functions 102-105 are displayed concurrently
with a "press for more options" key 107. A hierarchy of
menus describing the various systems and subsystems
controlled by the host computer may be accessed by

30   actuating the "press for more options" key 107.

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In this example, depressing the area over the
"Master Lights" virtual key 102 actuates a corresponding
mechanical switch through the cantilever action described
above. This is detected by the microcontroller, which
5   sends a corresponding signal to the host computer. In
response, the host computer may energize/de-energize a
preestablished configuration of room lighting.

Actuating the "More Light Scenes" 105 key displays a
preconfigured sub-system menu (not shown) wherein
10 alternative lighting patterns may be controlled (e.g.,
pool lighting; front outside lighting; back outside
lighting, etc.). The "Now Playing KTWV 94.7" key 103
displays the current channel setting on a radio receiver.
Actuating this key displays a sub-menu illustrated in
15 Fig. 9, wherein alternate preestablished radio station
settings may be accessed or alternate menus configured to
control different entertainment systems may be displayed
(e.g., compact audio disc player, tape player, laser
disc, television, video cassette player, etc.).

20   The "Alarm is NOT Armed" key 106 displays the
current status of the home alarm system. Depressing this
key accesses an alarm system sub-menu illustrated in
Figure 12 for controlling various alarm system functions.
The "Great Room Volume 25%" key 104 displays the current
25 audio volume setting for speakers located in the great
room. Depressing this key accesses the great room audio
volume control sub-menu illustrated in Figure 11 by which
various audio functions may be controlled (e.g., volume
up, volume down, mute, audio power off, etc.).

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Depressing the "Press for More Options" key 42 accesses
alternative preconfigured sub-menus (not shown).

Fig. 9 illustrates an example of an alarm system
sub-menu as it may appear on the keypad display after
5   depressing the "Alarm is NOT Armed" key 106 in Fig. 8.
Referring to Fig. 10, the alarm system sub-menu displays
on the keypad display five functions 122-126 and a "Press
to Exit/Return" function 127 The "Press to Exit/Return"
key 127 returns the user to the default menu from the
10   sub-system menu as illustrated in Fig. 10.

The functions displayed on the default menu
illustrated in Fig. 8 and the various sub-menus
illustrated in Figs. 9-11 may be optimized for an
individual user's application to provide instant access
15   to the most frequently used functions, including high
priority home control functions such as security or
lighting. According to the preferred embodiment of the
invention, the upper left key of the default menu
displays the main lighting scene, and the lower right key
20   displays a "Press For More Options" to access subsequent
menus. The invention is also designed so that the
default menu will be displayed after a preset time-out
period.

The default menu also provides access to all
25   functions and subsystems that do not appear on the
default menu. In the preferred embodiment of the present
invention, if more than five subsystems are being
controlled, four subsystems will be displayed on the main
menu and additional subsystems can be accessed by
30   pressing the "Press for More Options" key.

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It will be apparent that the number of systems that can be accessed by the invention is not limited by its design. According to the preferred embodiment of the invention, subsystem menus may provide up to five

5   functions on one display page, or four functions with a "Press for More Options" key to access additional subsystem functions. Thus, a very large number of subsystems may be accessed using the present invention.

The invention has been now been described in

10   fulfillment of the above noted objects. Specifically, a user interface has been described which is particularly suited for use in a home automation system. This interface combines advantages of a conventional touch screen (such as ease of use and accurate "key" placement)

15   with the advantages of a conventional mechanical keypad (such as reduced cost and tactile feedback).

While the invention has been specifically described with reference to particular aspects, features, and embodiments thereof in relation to its preferred

20   embodiment as a keypad interface for a home control system, other variations, modifications, and alternate embodiments will be apparent to those skilled in the art. It is intended that such variations, modifications and alternate embodiments are to be regarded as being within

25   scope of the invention.

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WHAT IS CLAIMED IS:

1.   A user interface comprising:

a liquid crystal display divided into a plurality of regions;

5   a microcontroller operatively coupled to a host controller, the microcontroller driving the liquid crystal display according to signals received from the host controller so as to display text or images on each of the plurality of regions of the liquid crystal

10   display;

a transparent member covering each of the regions of the liquid crystal display; and

a plurality of switch elements disposed proximal to the regions of the liquid crystal display, each of the

15   switch elements being actuated by the transparent member covering it when the transparent member is depressed by a user;

wherein the microcontroller detects actuation of the switch elements and provides an indication to the host

20   controller in response thereto.

2.   A user interface according to claim 1 further comprising a plurality of light emitting diodes, each disposed proximal to each region of the liquid crystal

25   display, the light emitting diodes being operated by the microcontroller.

3.   A user interface according to claim 2 wherein said light emitting diodes are multicolored.

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4.   A user interface according to claim 2 wherein the microcontroller operates the light emitting diodes on the basis of signals received from the host computer.

5   5.   A user interface according to claim 1 wherein the liquid crystal display is backlit.

6.   A user interface according to claim 5 further comprising a light sensor coupled to the microcontroller,
10   the microcontroller regulating the intensity of the backlighting of the liquid crystal display depending on the intensity of ambient light detected with the light sensor.

15   7.   A user interface according to claim 1 wherein the transparent member is made of Lexan.

8.   A user interface according to claim 1 wherein the liquid crystal display and the microcontroller are
20   mounted on a printed circuit board.

9.   A user interface according to claim 1 wherein the printed circuit board is mounted to a wall mounted electrical box.

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10.   A user interface according to claim 1 further comprising a faceplate which covers fasteners which mount the printed circuit board to the electrical box.

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11. A user interface according to claim 10 wherein
the faceplate is applied to the printed circuit board
with an adhesive.

5   12. A user interface according to claim 1 wherein
the host controller provides instructions to the
microcontroller whereby a menu of options are displayed
on the liquid crystal display to the user.

10   13. A user interface according to claim 12 wherein
the user indicates selection of a displayed option by
depressing the transparent member over the corresponding
region of the liquid crystal display.

15   14. A user interface according to claim 5 wherein
predetermined regions of the liquid crystal display are
backlit by separately controlled light emitting diodes,
whereby selected portions of the liquid crystal display
are operated independent of other portions.

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FIG. 1A
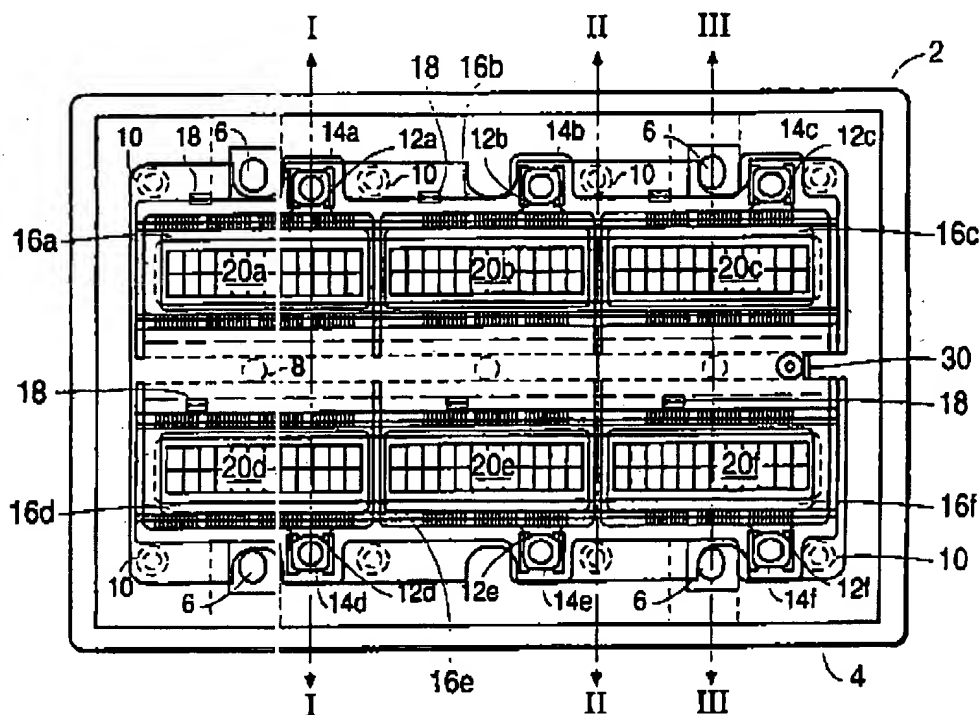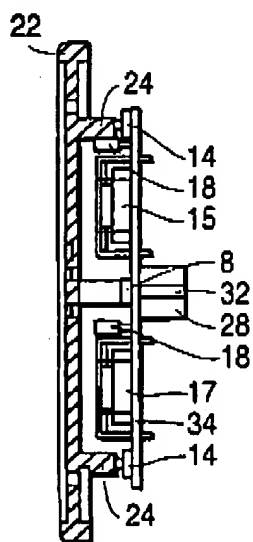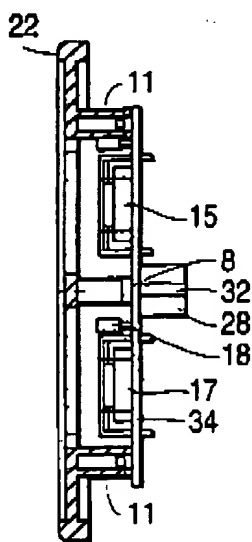
FIG.1B   FIG. 1C   FIG. 1D
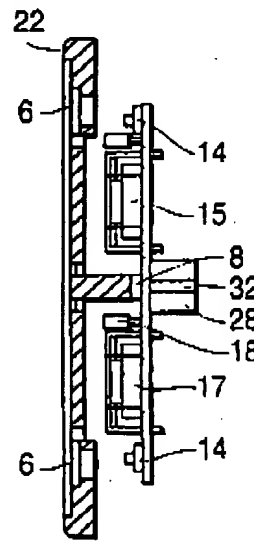
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FIG. 2A
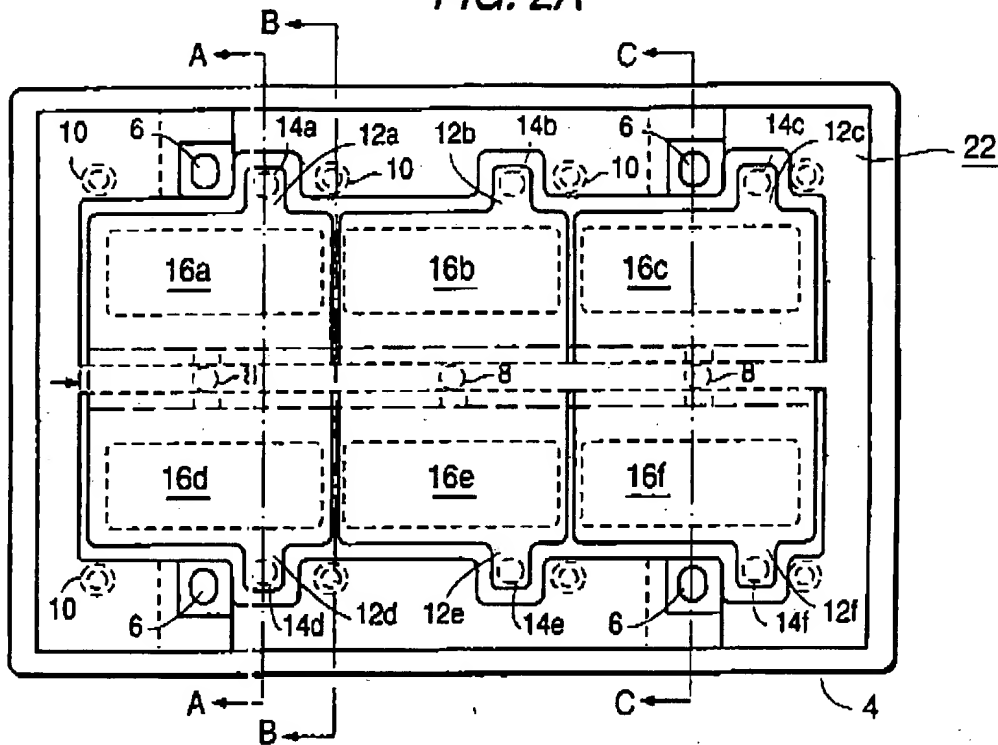
FIG. 2B
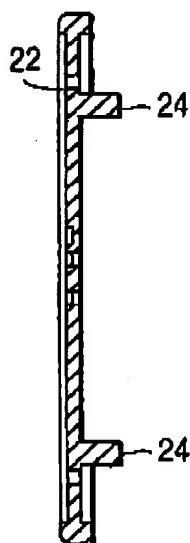
FIG. 2C

FIG. 2D
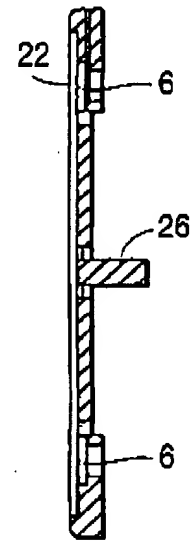
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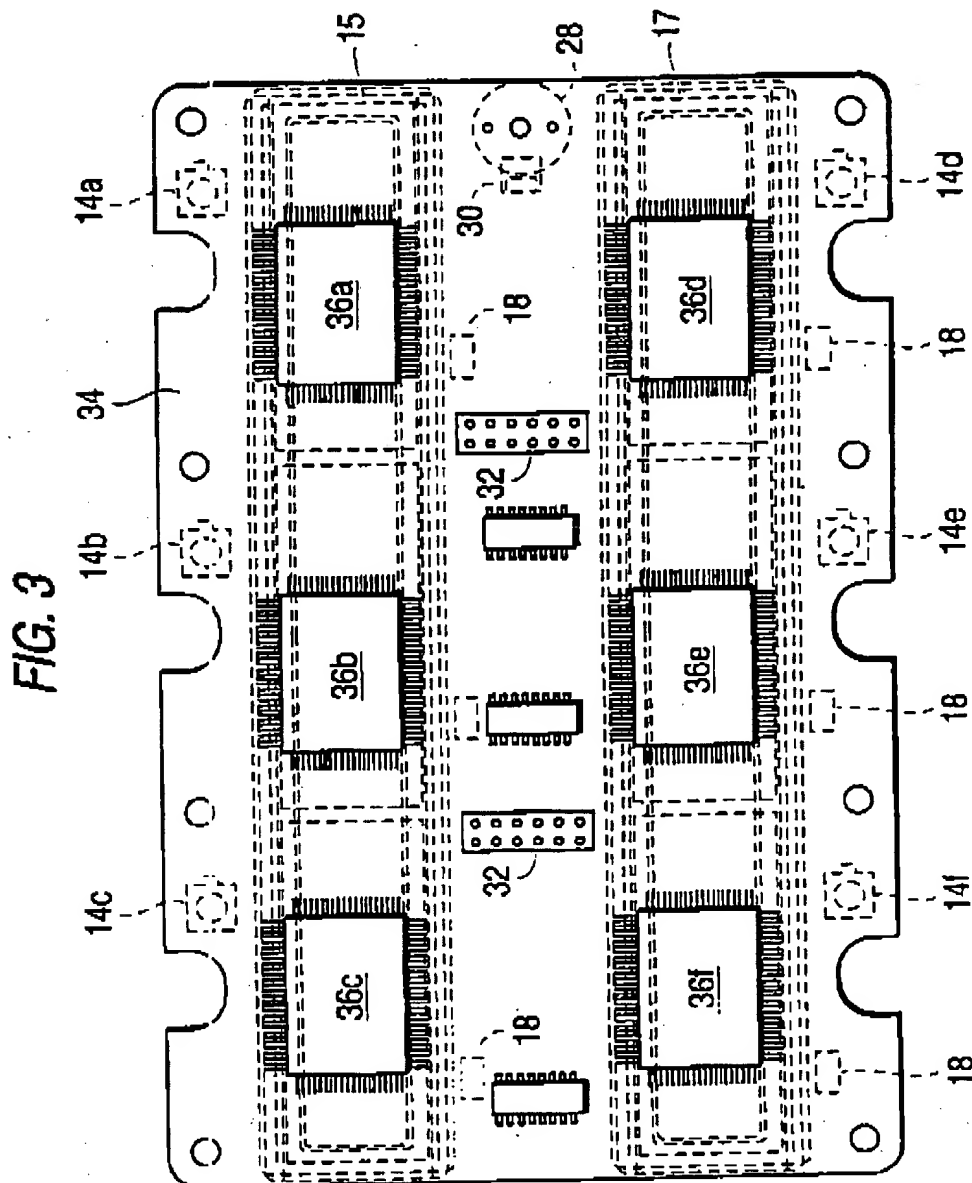
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FIG. 3

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FIG. 4

FIG. 6

FIG. 5

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FIG. 7

FIG. 8

Master Lights

Now Playing KTWV 94.7

Great Room Volume 25%

More Light Scenes

Alarm is NOT Armed

Press for More Options

101

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FIG. 9

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FIG. 10

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PAGE 64/73 * RCVD AT 7/22/2005 1:26:49 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/29 * DNIS:2738300 * CSID:631 549 0404 * DURATION (mm-ss):13-46

FIG. 11

Great Room Volume 25%

MUTE

Volume UP

Press to Exit/Return

Audio Power OFF

Volume DOWN
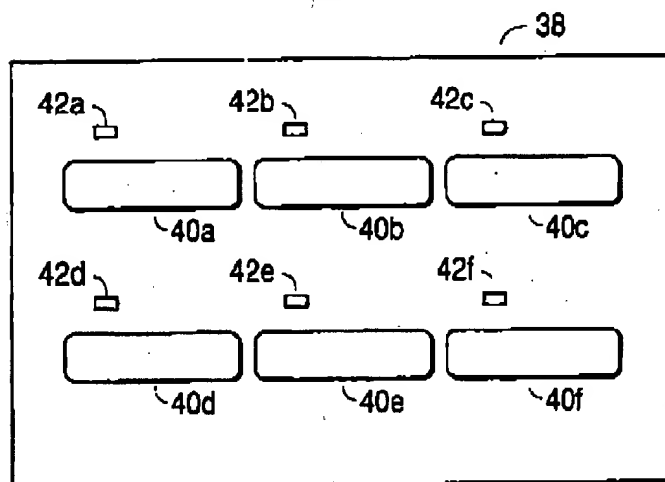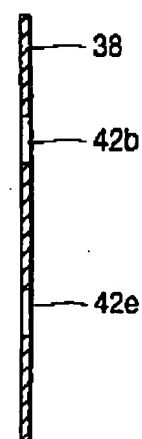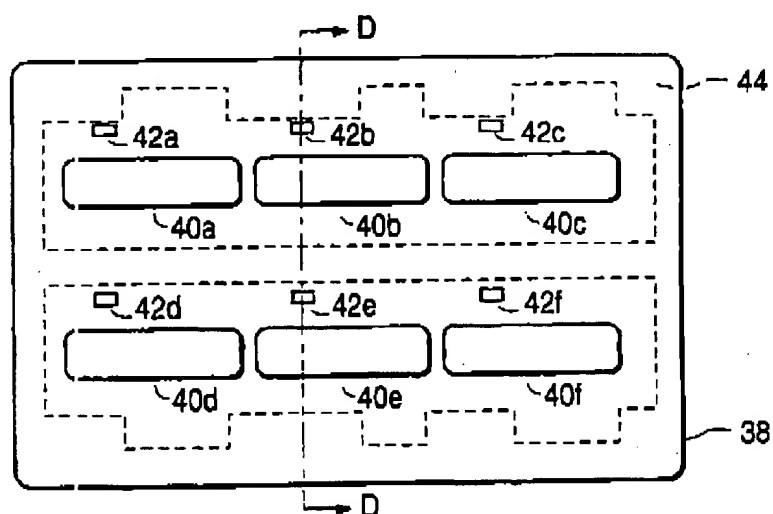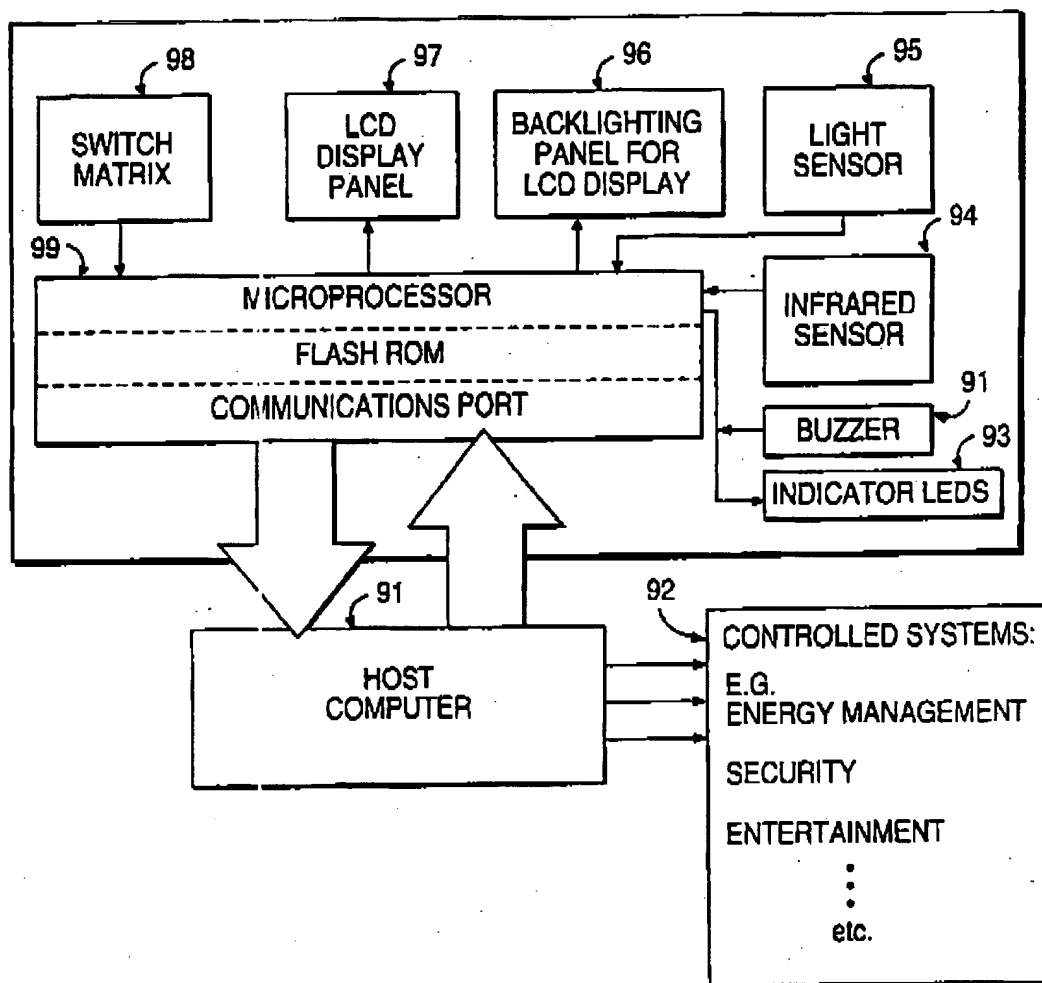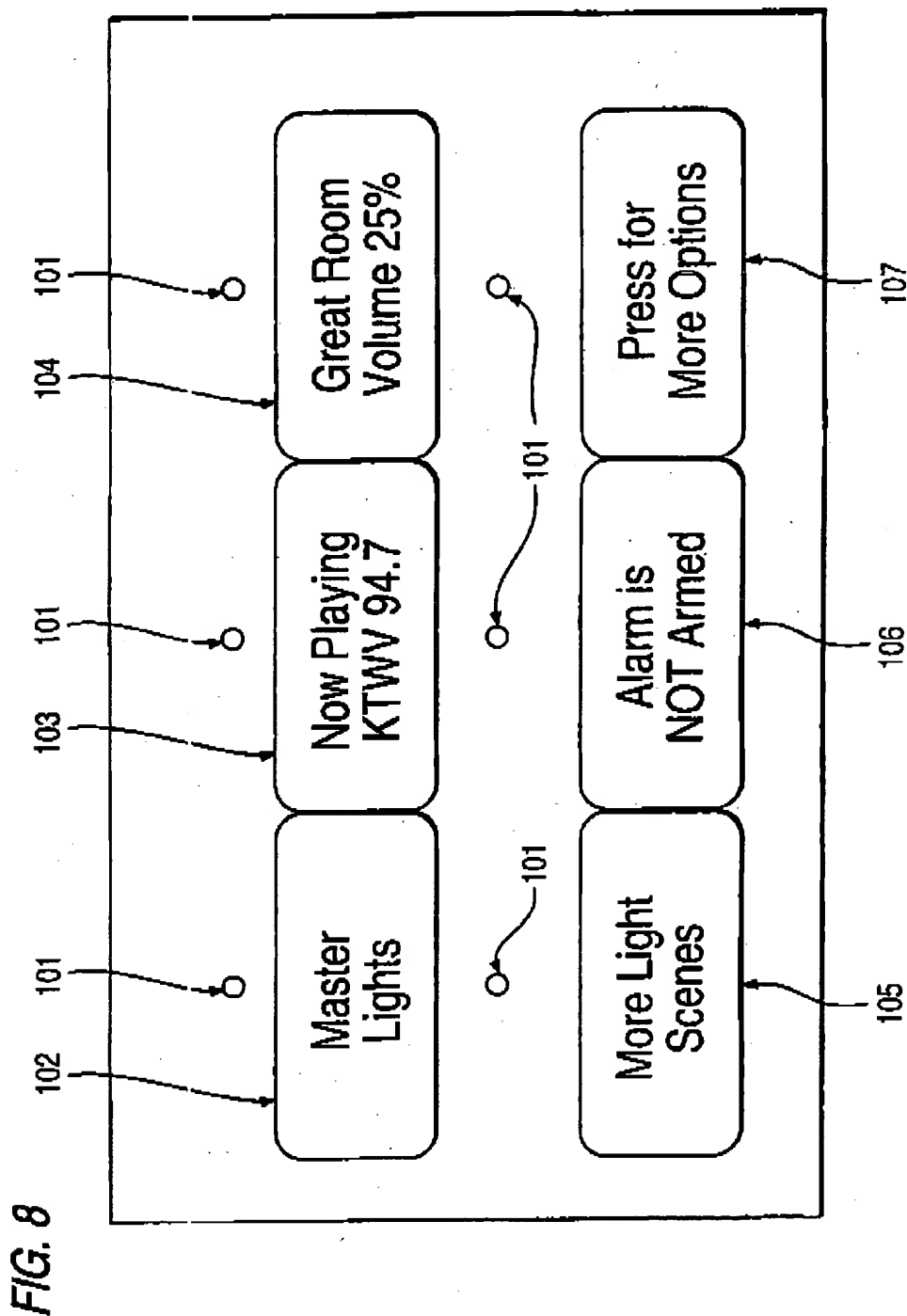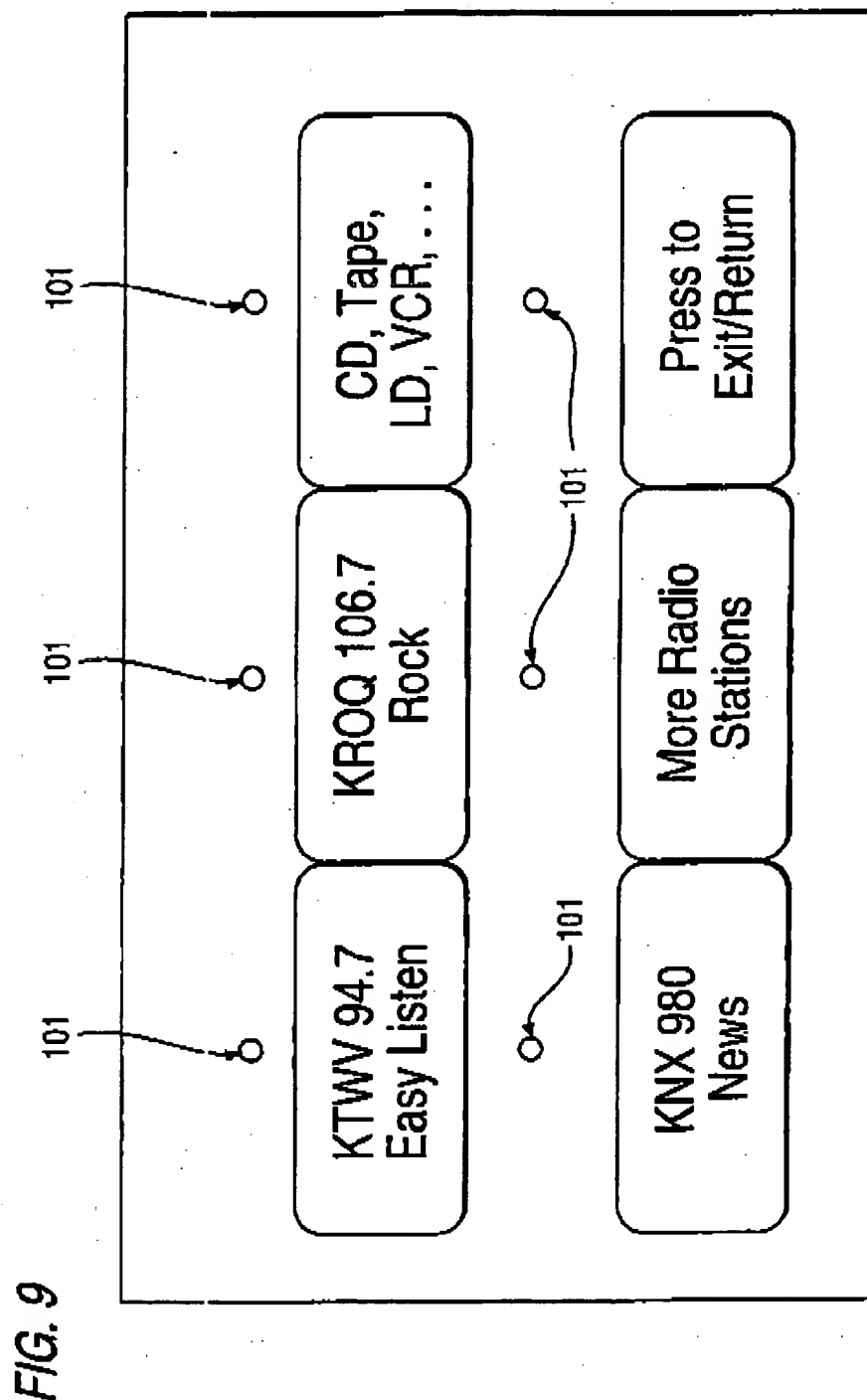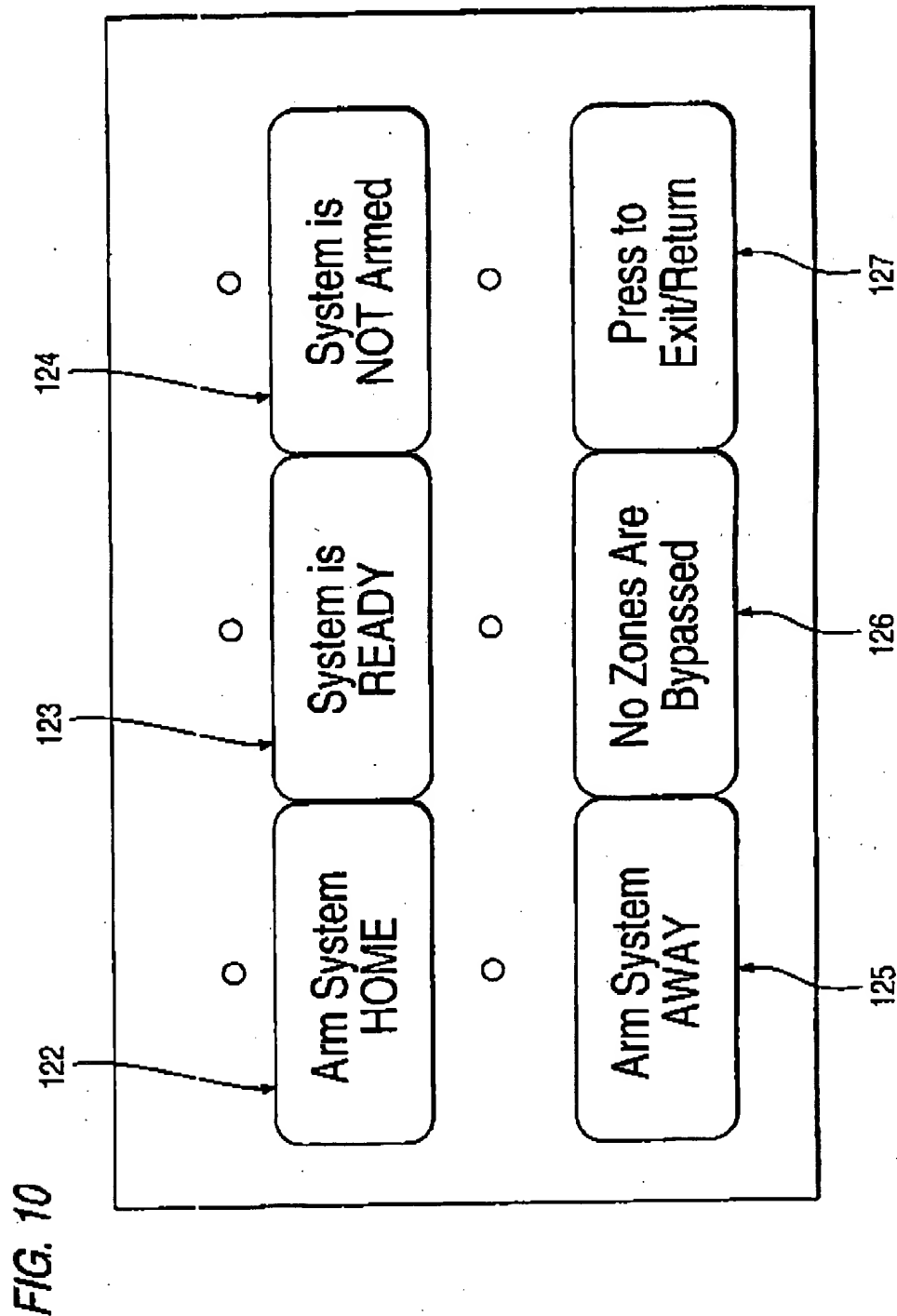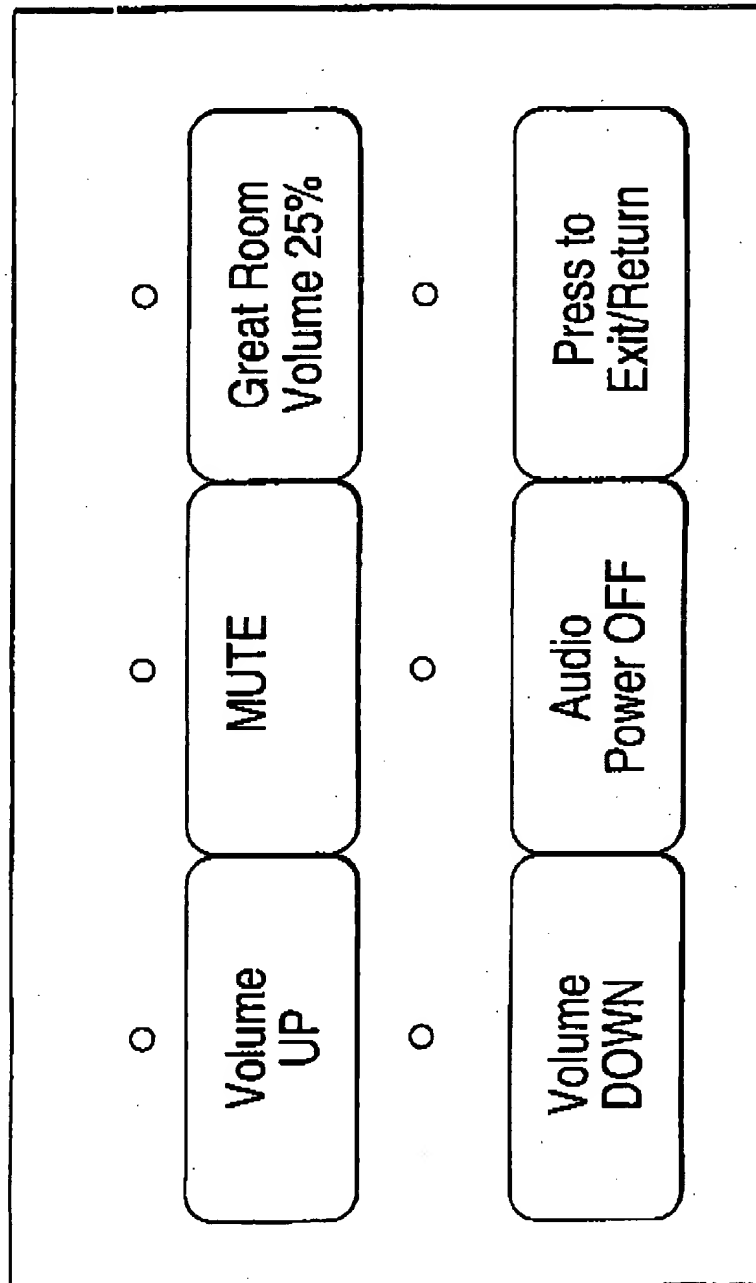
INTERNATIONAL SEARCH REPORT

International Application No.
PCT/US96/14520

A.   CLASSIFICATION OF SUBJECT MATTER

IPC(6)   : G09G 5/00
US CL   : 345/156

According to International Patent Classification (IPC) or to both national classification and IPC

B.   FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. :   345/156, 170, 171, 171, 172, 173, 83, 146

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, MAGAZINE DATABASE, IAC(SM)COMPUTER DATABASE
search terms: touch screen or panel, smart home or house, microcontrollers or processors, LCD, LED, light sensor

C.   DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,821,029 (LOGAN ET AL) 11 April 1989, figure 1, and column 3, line 45 to column 4 line 15.	1
Y	US, A, 5,396,226 (WAKE ET AL) 07 March 1995, figures 1, 2 and 3, and abstract.	1-14
Y	US, A, 5,034,602 (GARCIA, JR. ET AL) 23 July 1991, figure 2.	1-14
Y	US, A, 3,187,321 (KAMENY) 01 June 1965, figure 2.	1-14
Y	US, A, 4,810,937 (HAVEL) 07 March 1989, abstract.	3
Y	US, A, 5,097,396 (MYERS) 17 March 1992, abstract.	5,6,14

☒	Further documents are listed in the continuation of Box C.	☐	See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance		
"E"	earlier document published on or after the international filing date	"X"	document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 DECEMBER 1996	3 1 JAN 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer JOSEPH ACOSTA
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INTERNATIONAL SEARCH REPORT

Intc. .ional application No.
PCT/US96/14520

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,384,577 (MCLAUGHLIN ET AL) 24 January 1995, abstact and column 2, lines 26 to 28.	6
Y	US, A, 5,440,208 (USKALI ET AL) 08 August 1995, figure 3.	8, 14
Y	US, A, 4,066,850 (HEYS, JR) 03 January 1978, fugures 1, 2, 3, and 4.	9,10,11
Y	US, A, 4,360,716 (FIORELLA) 23 November 1982, abstract.	11
Y	US, A, 4,827,410 (CORREN) 02 May 1989, column 6, lines 54 to 55.	7
Y	US, A, 5,307,086 (GRIFFIN ET AL) 26 April 1994, figures 1 to 4.	12, 13

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